



# *The San Pedro River Case Study:* Using Science to Influence Integrated Decision-making for Watershed Management

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## Background

Vegetation change in the American West has been a subject of concern throughout the past century. Major regional shifts in dominant land cover have been reported in the literature and have largely been attributed to land-use impacts following human settlement in the 1870s. Other authors have hypothesized historical change in climate have accounted for vegetation change. Although several studies have addressed specific aspects of vegetation change in the Southwest, few have attempted to synthesize the cumulative impacts over a large regional or watershed area. Human land-use management practices are the most important factor influencing ecosystem structure and functioning at local, regional, and global scales. The type, magnitude, and distribution of land use is a major factor affecting contemporary ecological and hydrological condition and directly relates to the ability of the environment to provide ecosystem goods and services, e.g. water supply, wildlife habitat, and sustainable forage.

No where have the issues of landscape change and subsequent environmental impairment been of most concern than in the international watershed of the San Pedro River. The San Pedro River in northeast Sonora and southeast Arizona has been simultaneously called one the "Last Great Places" (The Nature Conservancy) and the "Fourth Most Endangered River System" (American Rivers) in the United States. For five years, 1995 through 2000, a broad partnership of community and business leaders, university faculty, and international government researchers and land managers have worked together to evaluate the consequences of natural and human-induced environmental change on the Upper San Pedro Watershed. Initially the San Pedro stakeholders were concerned whether landscape change had occurred within their community and whether that could be concretely measured and documented. In particular they were concerned about the stability of ecosystems and their vulnerability to change. As time evolved, community stakeholders became particularly concerned regarding sustainable endpoints such as water availability, wildlife habitat, water quality (erosion), and livestock forage (native grassland).

In response to the community concern, scientists and managers from about 20 U.S., 4 French, and 3 Mexican agencies and universities created an interdisciplinary, multi-national, and multi-agency consortium to harness their limited and unique resources within this geographical initiative. The Semi-Arid Land-Surface-Atmosphere (SALSA) Program was created and operated on the principle of voluntary collaboration whereby researchers and community stakeholders interact with one another across disciplinary, institutional, and political boundaries to address environmental problems. The purpose of the SALSA program was to facilitate scientific and decision management interactions and to serve as a platform for research coordination, data assimilation and synthesis, and information exchange. The ultimate product of the SALSA effort was to develop a comprehensive "knowledge-base" of data, interpretive information, and tools that will aid environmental decision-making within the San Pedro community.

The SALSA program sought to accomplish the community objective using both existing and innovative technologies coupled with sustained cooperation among scientists and community stakeholder groups. The work was pursued through two separate but highly interrelated ecosystem components, i.e. water balance and

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ecological complexity. Terrestrial water balance determines water availability, the primary factor limiting human and wildlife populations in semi-arid regions. Ecological complexity, e.g. species, habitat, and landscape diversity, is a key indicator of environmental quality and stability. Watersheds comprise well-bounded hydrological systems, and encompass many biological and cultural systems of interest. By examining the water balance and ecological complexity at the watershed scale, the SALSA results have direct applicability to environmental management activities based on community watershed units.

## Assessment Methodology and Tools

Traditionally, information for vegetation change has largely been derived from the technique of repeat photography or via historic land survey descriptions. This approach has been primarily qualitative in nature and focused on small areas or sites of concern. It is currently possible to measure change over large areas, such as watersheds or regions, and determine trends in ecological and hydrological condition using advanced space-based technologies, e.g. Landsat earth observing satellites. The San Pedro River community was interested in examining change throughout the entire watershed and thus remote imagery was acquired for four dates (1973, 1986, 1992, and 1997) over an approximately 25-year period. The watershed was characterized into a 10-vegetation class system selected by the stakeholder community and the derived digital land cover maps were analyzed in a geographical information system using ARC/INFO software. Change was analyzed using landscape statistical software to produce landscape statistics, including actual total extent throughout the watershed.

Acquisition of primary data and database development are initial features of any landscape indicator and assessment project. It also became necessary to develop a geospatial database browser for this project. Spatial coverages and the supporting information (metadata) were organized relative to their geographical availability and theme and made available for download in ARC/INFO export format. The information was acquired from a number of sources and includes data generated within the EPA. The metadata include important information relative to acquisition, location, processing level, file size, format and comply with Federal Geospatial Data Committee

standards. The San Pedro Browser (EPA/600/C-00/002) is currently accessible on-line at the EPA website (<http://www.epa.gov/nerlesd1/land-sci/san-pedro.htm>). Additionally, CD-ROM copies were produced and distributed to the stakeholder community.

## Study Results and the Role of Science

The experience in the San Pedro watershed demonstrated the value and the role of using science in the community decision-making process. The landscape characterization and change detection work were published and identified the significant changes that have taken place in the last quarter century (Kepner et al. 2000). The information was further used as input variables for hydrologic response models which demonstrated the affect landscape change has on stream runoff (erosion) and loss of ground water infiltration. Additionally, the information has been used to model for potential wildlife habitat and has been preliminary tested for development into a watershed assessment atlas. The Data Browser is currently being used by the interagency San Pedro Partnership Committee as the data source for community planning and development decisions relative to watershed protection and wildlife corridors and thus provides a focus for exchanging ideas and building consensus on significant environmental issues.

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